IN THE CLAIMS:

Claims 1-38 (Cancelled)

Claim 39 (Original) A method of producing a substantially relaxed, high-quality SiGe-on-insulator substrate material comprising the steps of:

subjecting a Si-containing substrate to a base oxygen ion implant step to form a damaged region that has an oxygen ion concentration that is sufficient to act as a diffusion barrier to Ge;

subjecting the Si-containing substrate having said damaged region to a second oxygen implant step to form an amorphous region that is shallower than the damaged region, said amorphous region having a surface layer of the Si-containing substrate thereon;

forming a Ge-containing layer atop the surface layer of the Si-containing substrate, said Ge-containing layer having a thickness from about 50 to about 500 nm and a Ge content from about 5 to about 40 atomic %;

heating the substrate to form a substantially relaxed SiGe layer atop said diffusion barrier layer, said heating comprises:

(i) first ramping up the substrate in an oxygen-containing gas to a first temperature that is sufficient to initiate formation of a buried oxide region in said substrate, while substantially avoiding slip generation;

(ii) first soaking at the first temperature to form a continuous buried oxide in said substrate;

(iii) second ramping up in an oxygen-containing gas from the first temperature to a second temperature that is sufficient to increase the thickness of the buried oxide in said substrate;

(iv) second soaking in an oxygen-containing gas at said second temperature to increase and control the thermal oxide thickness and to provide a sharpened interface between the relaxed SiGe layer and the buried oxide;

(v) ramping down from the second temperature to a third temperature that is less than or equal to the melting point of a final desired Ge concentration, while allowing Ge diffusion for concentration homogenization; and

(vi) oxidizing at said third temperature to provide the relaxed SiGe layer having said final Ge content and a thickness that is sufficient to minimize stacking faults.

Claim 40 (Original) The method of Claim 39 wherein said base oxygen implant step is performed at an energy from about 100 to about 220 keV and at a dose from about 1.5E17 to about 3E17 cm^{-2}.

Claim 41 (Original) The method of Claim 40 wherein the base oxygen implant step is performed at an energy from about 150 to about 175 keV and at a dose from about 1.8E17 to about 2.75E17 cm^{-2}.

Claim 42 (Original) The method of Claim 39 wherein said base oxygen implant is performed at a temperature from about 200°C to about 600°C at a beam current density from about 0.01 to about 0.1 milliamps cm^{-2}.

Claim 43 (Original) The method of Claim 39 wherein the second oxygen implant is performed at an energy from about 100 to about 220 keV and at a dose from about 1E15 to about 3E15 cm^{-2}.

Claim 44 (Original) The method of Claim 43 wherein the second oxygen implant is performed at an energy from about 150 to about 170 keV and at a dose from about 2E15 to about 2.75E15 cm^{-2}.

Claim 45 (Original) The method of Claim 39 wherein the second oxygen implant is performed at an implant temperature from about -200°C to about 150°C and at a beam current density from about 0.001 to about 0.01 mA cm^{-2}.

Claim 46 (Original) The method of Claim 39 wherein the Ge-containing layer is formed by an epitaxial growth process selected from the group consisting of low-pressure chemical vapor deposition, atmospheric pressure chemical vapor deposition, ultra-high vacuum chemical vapor deposition, molecular beam epitaxy, and plasma-enhanced chemical vapor deposition.

Claim 47 (Original) The method of Claim 39 wherein the Ge source used during said epitaxial growth process is isotopically enriched in any naturally occurring masses.

Claim 48 (Original) The method of Claim 39 wherein said Ge-containing layer has a thickness from about 100 to about 200 nm and a Ge content from about 15 to about 25 atomic % .

Claim 49 (Original) The method of Claim 39 further comprising forming a Si-containing cap layer atop said Ge-containing layer prior to said heating.

Claim 50 (Original) The method of Claim 49 wherein said Si-containing cap layer comprises epi-Si, epi-SiGe, a:Si, a:SiGe, single or polycrystalline Si or any combination and multilayer thereof.

Claim 51 (Original) The method of Claim 39 wherein a Si-containing buffer layer is formed atop said Si-containing substrate prior to the formation of said Ge-containing layer.

Claim 52 (Original) The method of Claim 39 wherein a surface oxide layer forms during said heating.

Claim 53 (Original) The method of Claim 52 further comprising removing said surface oxide layer utilizing a wet chemical or reactive-ion etch process.

Claim 54 (Original) The method of Claim 39 further comprising a step of subjecting the relaxed SiGe layer to a non-selective thinning process after said heating.

Claim 55 (Original) The method of Claim 54 wherein the non-selective thinning process comprises chemical mechanical polishing, grinding, high-pressure oxidation, wet etching, steam oxidation, gas-cluster beam thinning or any combination thereof.

Claim 56 (Original) The method of Claim 55 wherein the non-selective thinning process is chemical mechanical polishing.

Claim 57 (Original) The method of Claim 39 wherein the first temperature of said first ramp up is from about 1275°C to about 1320°C.

Claim 58 (Original) The method of Claim 39 wherein the first ramp up is performed using a rate of less than or equal to 1°C/min.

Claim 59 (Original) The method of Claim 39 wherein the oxygen-containing gas may further be diluted with an inert gas.

Claim 60 (Original) The method of Claim 39 wherein said first soak is performed for a period of time from about 0.5 to about 5 hours using the same or substantially the same oxygen-containing gas as the first ramp up.

Claim 61 (Original) The method of Claim 39 wherein the second temperature of the second ramp up is from about 1315°C to about 1335°C.

Claim 62 (Original) The method of Claim 61 wherein said second ramp up is performed at a rate of less than or equal to 1°C/min.

Claim 63 (Original) The method of Claim 39 wherein the second ramp up is performed in an oxygen-containing gas that is admixed with an inert gas.

Claim 64 (Original) The method of Claim 39 wherein the second soaking is performed for a time period from about 1 to about 10 hours in the same or substantially the same ambient as used in the second ramp up.

Claim 65 (Original) The method of Claim 39 wherein the third temperature of said ramping down is from about 1300°C to about 1200°C.

Claim 66 (Original) The method of Claim 39 wherein said ramp down is performed at a rate of less than or equal to 1°C/min.

Claim 67 (Original) The method of Claim 39 wherein said oxidizing is performed in 100% oxygen, steam or an oxygen-containing gas that is diluted with an inert gas.

Claim 68 (Original) The method of Claim 39 wherein the oxidizing is performed for a time period from about 1 to about 10 hours.

Claim 69 (Original) The method of Claim 39 further comprising growing an additional SiGe layer atop said substantially relaxed SiGe layer.

Claim 70 (Original) The method of Claim 69 further comprising forming a strained Si-containing layer atop said additional SiGe layer.

Claim 71 (Original) The method of Claim 39 further comprising forming a strained Si-containing layer atop said substantially relaxed SiGe layer.

Claim 72 (Original) A substrate material comprising:

a Si-containing substrate;
a buried oxide that is resistant to Ge diffusion present atop said Si-containing substrate; and

a substantially relaxed SiGe layer present atop said buried oxide, wherein said substantially relaxed SiGe layer has a surface roughness of about 1.5 nm or less, and a crystal defect density of about 5×10^7 /cm^2 or less.

Claim 73 (Original) The substrate material of Claim 72 further comprising a first strained Si-containing layer located atop the substantially relaxed SiGe layer.

Claim 74 (Original) The substrate material of Claim 73 further comprising alternating layers of relaxed SiGe and strained Si located atop the first strained Si-containing layer.

Claim 75 (Original) The substrate material of Claim 72 further comprising a layer composed of at least III-V elements located atop the substantially relaxed SiGe layer.

Claim 76 (Original) The substrate material of Claim 72 wherein said buried oxide has a mini-breakdown field of about 6MV/cm or greater.